Proposed Change No. 70
Supplement No. 1

MAINE YANKEE ATOMIC POWER COMPANY

ENGINEERING OFFICE

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WESTBORO, MASSACHUSETTS 01581
617-366-9011

PC-70-4
WMY 80-136

September 29, 1980

United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Office of Nuclear Reactor Regulation

References:
(a) License No. DPR-36 (Docket No. 50-309)
(b) USNRC Letter to YAEC Re: MYAPC, dated June 22, 1979
(c) USNRC ASLB Memorandum and Order, dated July 14, 1980
(d) MYAPC Letter to USNRC, dated February 28, 1980 (WMY 80-34)
(e) MYAPC Letter to USNRC, dated February 15, 1980 (WMY 80-29)
(f) MYAPC Proposed Change No. 70 to USNRC, dated September 18, 1979 (WMY 79-97)

Subject: Modified Spent Fuel Pin Storage with New 10.5" Center Racks

Dear Sir:

Pursuant to the directions expressed in Reference (b), and in accordance with Section 50.59 of the Commission Regulations, Maine Yankee Atomic Power Company hereby proposes the following modification.

PROPOSED CHANGE: Reference is made to Section 1 of Maine Yankee's Technical Specifications and Section 9.10 of the Final Safety Analysis Report. We propose the following:

a) Replacement of the existing spent fuel racks in which spent fuel assemblies are stored on 12 inch centers with new racks in which spent fuel assemblies and/or spent fuel pin storage containers are stored on 10.5 inch centers.

   This increases the long term spent fuel storage capacity of the spent fuel pool from 953 storage locations to 1500 storage locations which can accommodate 1500 spent fuel assemblies in their as discharged form or 2430 spent fuel assemblies consolidated for pin storage as described in Reference (f).

b) Utilization, if and when necessary, of a short term spent fuel storage rack of a design similar to that of the long term storage racks proposed in a) above which occupies the spent fuel cask laydown area of the spent fuel pool.

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The short term spent fuel storage rack would provide an additional 121 spent fuel storage locations.

The spent fuel storage racks proposed in a) and b) above will provide storage capability for a total of 2551 spent fuel assemblies.

These proposed spent fuel storage racks will meet the design criteria detailed in Reference (f).

As a result of the aforementioned proposal, Maine Yankee requests a change to subsection 1.1, Fuel Storage. A revised page 1.1-1 is provided as Attachment A.

REASON FOR CHANGE: One purpose of this supplement is to provide an additional increase in the number of long term spent fuel assembly storage locations in the spent fuel pool racks, and ensure the new racks are of sufficient strength to accept the loads imposed by the arrays of fuel pins described in Reference (f), without the need of adding braces and stiffening members to the existing racks.

Another purpose is to ready a contingency plan extending the period during which Maine Yankee can accomplish full core rejection should pin storage and/or reracking fail to be implemented in time to do so.

Maine Yankee believes that due to schedule uncertainties related to the pin storage and reracking concept, it is prudent to prepare to extend full core rejection capability prior to that point at which this capability will be lost, i.e., 1984. Therefore, a rack will be designed to the same neutronic, thermal-hydraulic and mechanical criteria utilized in the design of the permanent spent fuel racks described in Reference (f) and supplemented herein.

The Maine Yankee Technical Specifications will be changed to reflect the utilization of K_{eff} 0.95 with the spent fuel pool filled with unborated water as a design criterion. This criterion is in accordance with current industry practice.*

DESCRIPTION OF CHANGE: Attachment B contains a detailed description of the change. In summary, this supplement seeks approval to expand Maine Yankee's long term storage capacity by reracking with further densified racks intended to accept spent fuel assemblies either in their as discharged forms or in the form of stored pins as detailed in Reference (f).

In addition, we propose a short term spent fuel storage rack (contingency rack) which can be installed in the spent fuel cask laydown area, if and when needed.

SAFETY CONSIDERATIONS: The spent fuel storage facility has no effect on plant operation or protection. The facility serves as a storage facility for spent fuel prior to shipment for reprocessing or disposal. The proposed

* ANSI N210-1976 Design Objectives for Light Water Reactor Spent Fuel Storage Facility at Nuclear Power Station

modification as supplemented only increases the storage capacity of the existing racks within the design limits and analyses of the FSAR and Proposed Change No. 28.

The storage of additional spent fuel as part of the modification is considered permissible within the scope of previously submitted Proposed Change No. 25, which permits the licensee to receive, possess and use at any time, special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation as described in the Final Safety Analysis Report, as supplemented and amended.

Based on the considerations herein, it is concluded that there is reasonable assurance that operation of the Maine Yankee Plant with these Spent Fuel Storage Facility modifications will not endanger the health and safety of the public. This proposed change supplement has been reviewed by the Nuclear Safety Audit and Review Committee.

FEE DETERMINATION: The proposed change requires an approval that involves a single safety issue and is deemed not to involve a significant hazards consideration. For this reason, Maine Yankee Atomic Power Company proposes this change as a Class III Amendment. A payment of $4,000 was previously made concurrent with the submittal of Proposed Change No. 70, and therefore, no additional payment is deemed necessary.

SCHEDULE OF CHANGE: The proposed reracking and spent fuel consolidation will be implemented on a phased basis to provide an increasing capacity consistent with the normal refueling cycle.

Very truly yours,

MAINE YANKEE ATOMIC POWER COMPANY

W P Johnson

W. P. Johnson
Vice President

Attachments

COMMONWEALTH OF MASSACHUSETTS)
)ss
COUNTY OF WORCESTER)

Then personally appeared before me, W. P. Johnson, who, being duly sworn, did state that he is a Vice President of Maine Yankee Atomic Power Company, that he is duly authorized to execute and file the foregoing request in the name and on the behalf of Maine Yankee Atomic Power Company, and that the statements therein are true to the best of his knowledge and belief.

Robert H. Groce

Robert H. Groce Notary Public
My Commission Expires September 14, 1984

ROBERT H. GROCE
MASSACHUSETTS
NOTARY PUBLIC

Attachment A

1.1 Fuel Storage

Applicability: Applies to the capacity and storage arrangement of the new and spent fuel facility.

Objective: To describe and define those aspects of fuel storage which relate to the prevention of criticality in the fuel storage facility.

Specification:

A. The new and spent fuel pit structures, including fuel racks, are designed to withstand the anticipated earthquake loadings as Class I structures. The spent fuel pit is lined with stainless steel to ensure against loss of water.

B. Fuel is stored vertically in racks. The racks are designed to maintain fuel assembly center to center distances that will assure $K_{eff} \leq 0.95$ even with the spent fuel pool filled with unborated water.

C. Whenever there is fuel in the spent fuel pit, except for initial new fuel storage, the spent fuel storage pit is filled with water borated to the refueling water boron concentration. This concentration matches that in the reactor cavity and refueling canal during refueling operations.

Attachment B

I. Introduction

Proposed Change 70, Supplement 1, seeks approval to expand Maine Yankee's long-term spent fuel storage capacity by reracking with further densified racks intended to accept spent fuel assemblies in their as discharged form and in the form of stored pins as proposed earlier. In this supplement, we propose to replace the existing racks in which fuel assemblies are stored on 12" centers with new racks in which fuel assemblies are to be stored on 10.5" centers. This reduced assembly spacing is reflective of currently employed spent fuel rack designs at other facilities.

In addition to providing a significant increase in the number of spent fuel assembly storage locations in spent fuel pool racks, the new design is endowed with sufficient strength to accept the loads imposed by the heavier arrays of fuel pins described in the pin storage concept proposed earlier, with a minimum need for braces and stiffening members that would have had to be added to existing racks to accept the same loads. Minimizing the installation of braces under water is a considerable advantage.

Furthermore, Maine Yankee has determined that due to the uncertainties in the projected schedule for approval and implementation of the pin storage and reracking concepts, it is prudent to prepare for the possibility that full core rejection capability will have to be provided beyond the point at which this capability is projected to be lost (1984) without approval and implementation of pin storage and/or reracking. Therefore, a spent fuel rack which can be installed in the spent fuel cask laydown area, if and when needed, is further proposed by this supplement. This rack is designed to the same thermal-hydraulic, and mechanical criteria utilized in the design of the permanent spent fuel racks described in Proposed Change 70. The 10.5" rack design will be common throughout the pool, inclusive of this special rack for the cask laydown area.

The short term spent fuel storage rack is intended to be used for short term storage of spent fuel assemblies discharged in full core rejection. Following completion of activities necessitating full core rejection (e.g., inservice inspection of the reactor vessel and internals) the freshly discharged fuel assemblies would be reloaded into the reactor core, leaving the short term storage rack empty, whereupon it can be removed from the spent fuel cask laydown area.

Maine Yankee, therefore, seeks approval to 1) create a short term spent fuel storage capacity to extend full core rejection by making available, as needed, a free standing spent fuel rack fitting into the spent fuel cask laydown area and 2) extend over the balance of the pool racks of a similar design. The analysis that follows supports the requested change and demonstrates that approval of such change creates no undue hazard to the health and safety of the public.

II. Thermal Hydraulic Analysis

To assure that both consolidated storage containers and fuel assemblies receive adequate local cooling, a detailed thermal/hydraulic analysis was conducted. The criteria for adequate cooling is the prevention of nucleate boiling in the fuel rack under the maximum pool heat load conditions. This analysis utilized a manual calculational technique. This technique predicted conservative results when compared to the RETRAN calculations performed for the original submittal (PC 70-1). As before, a selected row of fuel storage cells containing the maximum number of cells in any row (35) across the minimum width of the pool was modeled.

Coolant is assumed to flow symmetrically from either end of the row down along the pool floor before entering the storage cells. This situation is represented in Figure 2.2 with flow from either end cooling 17 1/2 fuel cells.

Selection of a single row of storage cells, containing either consolidated storage containers or fuel assemblies, provides a conservative thermal evaluation of any possible assembly loading or placement in the spent fuel pool.

In the evaluation of the row of spent fuel pin storage containers, it was conservatively assumed that the storage containers were composed of fuel pins taken from fuel assemblies which had been removed from the reactor and cooled for 120 days. (Initially, Maine Yankee does not intend to disassemble any fuel that has been cooled less than three years.) The operating history of these pins while in the reactor was assumed to be infinite. Additionally, a row of freshly discharged fuel assemblies was also addressed. These fuel assemblies were conservatively assumed to cool in the reactor for only three days following shutdown prior to being placed in the pool. Assembly average exposures of 44,500 MWD/MTU, a conservatively high burnup, were assumed.

The maximum pool heat load and bulk pool stabilization temperature occurs when a full core is discharged just after a shutdown from full power. Using Branch Technical Position APCSB 9-2 guidelines (Rev. 1, 11/24/75), cooling times were established consistent with the above "worst case" full core discharge. To bound all future considerations, the full core discharge was assumed to fill the last available spaces in the pool with the assumption that all previously discharged spent fuel has been stored in spent fuel pin storage containers once it has cooled for 120 days. Required cooling times for the full core discharge are based on not exceeding a bulk pool temperature of 154°F or a heat load of 22×10^6 BTU/hr, assuming a primary component cooling water temperature of 85°F as described in the FSAR. In the event that a full core discharge becomes necessary, pool temperatures will be monitored. The bulk pool temperature will be controlled by simply limiting fuel movement from the reactor to the pool.

Conservative fluid fricton and form losses were assumed for all flow paths.

The channel region between each fuel storage cell was assumed to be heated by gamma deposition in the channel walls. Results indicate that all spent fuel pin storage containers and spent fuel assemblies receive adequate flow. The outlet conditions of the hottest compacted bundle and the hottest discharged fuel assembly are shown in Table 2.1.

The equilibrium void fraction in the assemblies and in the space between fuel storage cells is zero. Thus, boiling is not of concern as a source of moderator density variations in reactivity calculations.

III. Criticality Analysis

The criticality analysis for both the contingency rack for use in the cask laydown area and the reracking of the spent fuel pool is based on the revised methodology described in Reference 5. For the purpose of the criticality calculations, the design of the two racks is identical, therefore, the two separate locations will not be discussed independently. Additionally, only normal fuel assemblies were considered in this analysis. Consideration of pin compaction (Reference 1) has shown a reduced pitch lattice to be a less reactive configuration and therefore bounded by the presented results.

Methodology and Assumptions

Criticality calculations were performed utilizing the methodology described in Reference 5. NITAWAL, from the AMPX system of codes (Reference 9), was used for cross-section generation for KENO IV (Reference 10) Monte Carlo calculations of reactivity. The Nordheim Integral Treatment was utilized for the reasonance calculation. The well known 123 energy group ORNL library was the cross section source. The complete 123 energy group structure is accessed by KENO IV. The use of KENO IV for criticality determinations provides a more exact calculation than previous calculational tools (Reference 2).

The methodology, as described, was benchmarked against the critical experiments performed at Battelle Pacific Northwest Laboratories (BNL) (References 11, 12) and at Babcock & Wilcox (B & W) (Reference 13). The BNL criticals, three subcritical clusters, used two enrichments of 2.35 and 4.30 w/o. In addition, BORAL plates were utilized as a poison material between clusters in several experiments. The B & W criticals, 2.46 w/o fuel pins, are arrays of nine assemblies in a fuel storage rack configuration. BORAL poison plates were also used in these experiments.

It should be noted that not all the critical experiments were analyzed. Cases containing BORAL poison plates were given special emphasis for benchmarking of this application. Results for the sample of experiments analyzed gave excellent results with a mean K_{eff} of 1.0012 with a standard deviation of 0.0023 ΔK. For conservatism, an uncertainty in reactivity for this method will be taken as 0.02 ΔK as applied to the calculated results.

The criticality calculation for the spent fuel storage racks assumes the mechanical uncertainties to be at "worst case" conditions. This represents minimum water inside the flux trap and minimum BORAL plate thickness. The nominal case also utilizes the 95/95 confidence level Boron-10 content as described in Brooks and Perkins report No. 540

(0.007235 atom B-10/bn-cm). (Reference 4) Additionally, a significant number of other conservative assumptions were used in this analysis, i.e.:

i) Unirradiated (Fresh) fuel at 4.1 w/o U-235
ii) No soluble poison in the pool water
iii) No axial or radial leakage from the racks
iv) Calculations performed at the most reactive pool water temperature anticipated (68°F)

The increase in allowable fuel enrichment analyzed in this supplement is representative of the enrichment limit which might be needed for 18-month fuel cycle operation. The rack spacing and enrichment analyzed is reflective of presently employed industry fuel rack designs.

Nominal Conditions

The result of the nominal rack condition at worst case mechanical conditions is a K_{eff} of 0.90676 ± 0.0045. With uncertainties, as calculated below, the K_{eff} is 0.92869.

$$\text{Uncertainty} = [(\text{Calculational bias})^2 + \text{KENO Uncertainty})^2]^{1/2}$$
$$\text{Uncertainty} = [(0.02)^2 + (0.0090)^2]^{1/2} = 0.02193\ \Delta K$$

The K_{eff} for the norminal rack design with uncertainties is well below the required (Reference 7) 0.95 target for K_{eff}.

The variation of rack $K_{effective}$ with uncertainties considered, relative to the storage lattice pitch and the atom density of Boron-10 in the BORAL plate is presented in Figures 3.1 and 3.2 respectively.

ABNORMAL CONFIGURATIONS

Technical Specification 1.1.c requires that the spent fuel pool be maintained at the refueling water concentration (1720 PPM). The NRC Guideline (Reference 8) permits crediting this pool boron concentration under accident conditions. Fuel handling incidents which would result in an increase in reactivity were examined on this basis. No abnormal configurations were found that exceeded the shutdown margin provided by this high soluble boron concentration.

IV. Mechanical, Material and Structural Considerations

The description of analytical approach and bases in PC 70 remains applicable. The new racks (10.5 inch centers) will be designed to accommodate the increased weight and will satisfy all design bases as stated in PC 70.

V. Radiological

The description of the limiting case in PC 70 remains bounding.

References:

(1) Maine Yankee letter to NRC, WMY78-104, November 22, 1978.

(2) YAEC-1090, "Criticality Calculations on Maine Yankee Spent Fuel Racks Containing Boron", November, 1975.

(3) MYAPC letter to USNRC, March 27, 1975 (Proposed Change No. 28)

(4) "Quantitative Analysis of BORAL Panels". Brooks and Perkins Report No. 540, July 20, 1976.

(5) YAEC-1224, "Yankee Criticality Calculational Methodology", September, 1980.

(6) ANSI N16.1 - 1975, "American National Standard for Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors".

(7) ANSI N210-1976, "Design Objectives for Light Water Reactor Fuel Storage Facilities at Nuclear Power Stations."

(8) NRC Guideline, "Review and Acceptance of Spent Fuel Storage and Handling Applications", April 1978.

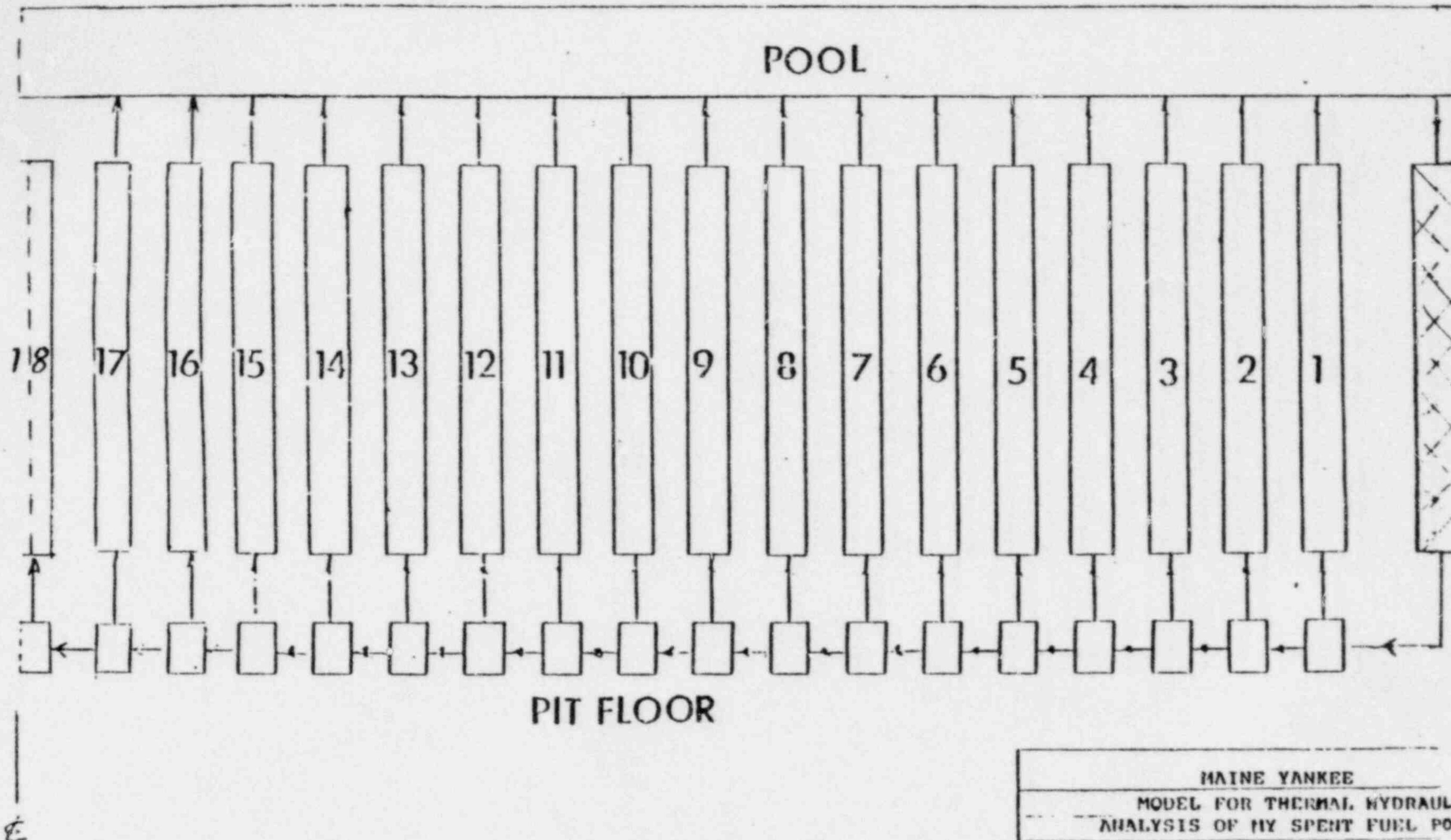
(9) ORNL/TM-3706, "AMPX: A Modular Code System for Generating Coupled Multi-Group Neutron-Gamma Libraries for ENDF/B", N. M. Greene et. al, 1976.

(10) ORNL-494F, "KENO-IV - An Improved Monte Carlo Criticality Program", L. M. Petrie, N. F. Cross, 1975.

(11) PNL-2438, "Critical Separation Between Subcritical Clusters of 235 wt. % U^{235} Enriched UO_2 Rods in Water With Fixed Neutron Poisons", S. R. Bierman, 1977.

(12) NUREG/CR-0073, "Critical Separation Between Subcritical Clusters of 4.29 wt. % U^{235} Enriched UO_2 Rods in Water With Fixed Neutron Poisons, S. R. Bierman, 1977.

(13) BAW-1484-7, "Critical Experiments Supporting Close Proximity [illegible] Storage of Power Reactor Fuel", M. N. Baldwin, et.at., July, 1979.



MAINE YANKEE
MODEL FOR THERMAL HYDRAULIC ANALYSIS OF MY SPENT FUEL POOL

FUEL BUNDLES

DOWN FLOW AREA

FIGURE 2.2

TABLE 2.1

	Maximum Outlet Temp. (°F)	Maximum Enthalpy BTU/lbm)	Void Fraction
Hottest Pin Bundle or Hottest Fuel Assembly	223	191	0.
Saturation Condition at Outlet Height	234	202.4	—

Figure 3.1

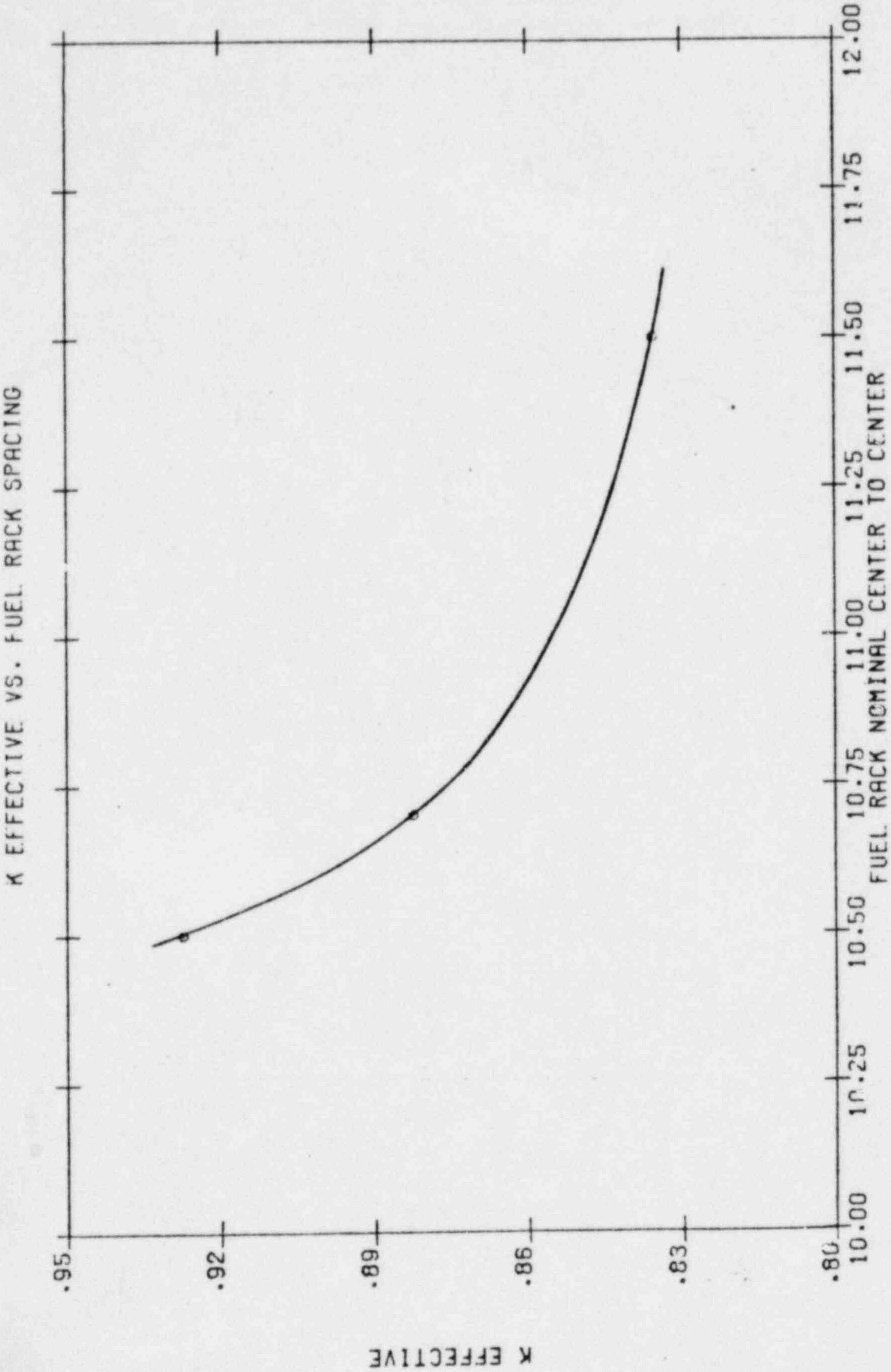
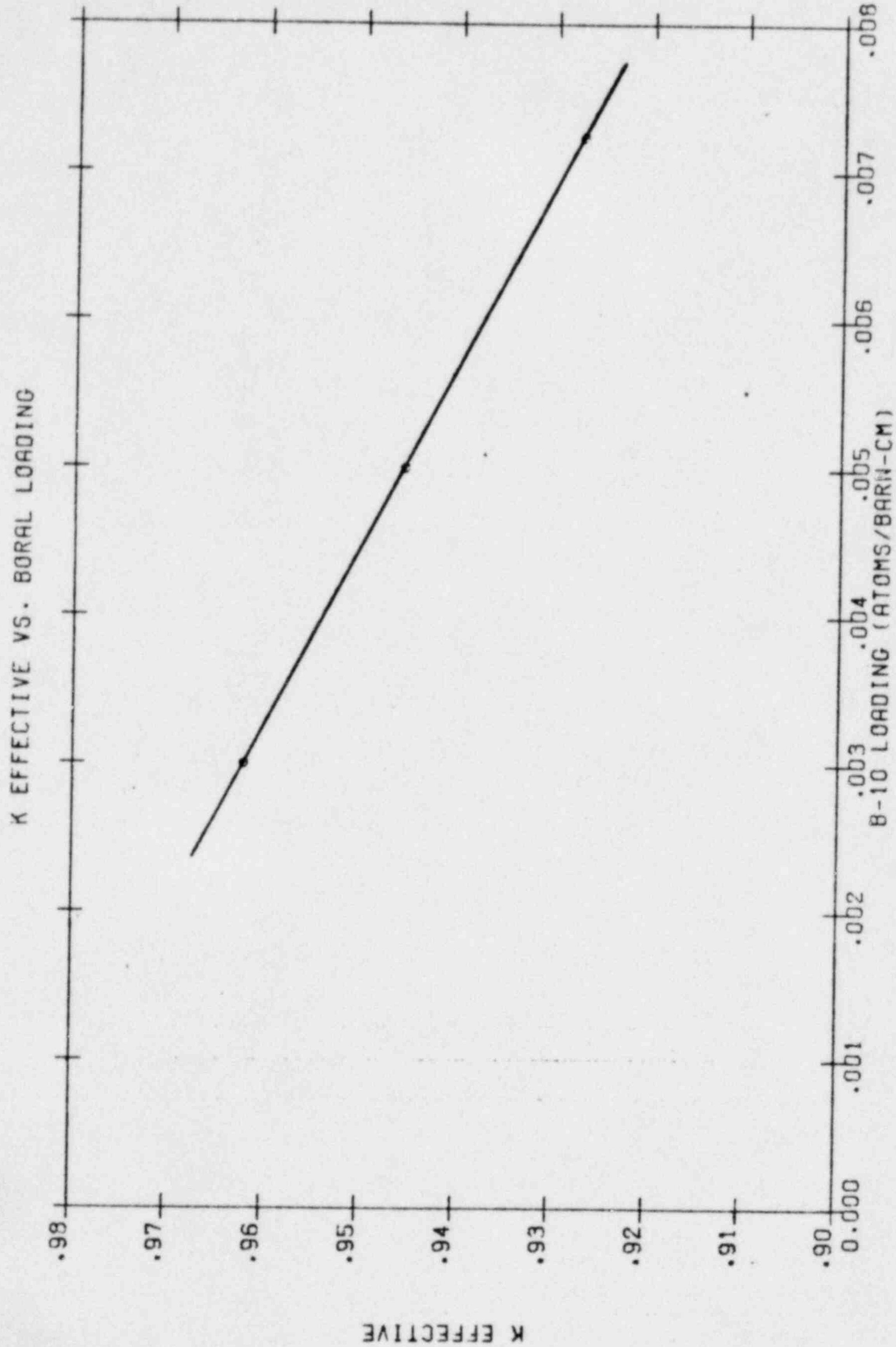

K EFFECTIVE VS. FUEL RACK SPACING
K EFFECTIVE
.95
.92
.89
.86
.83
.80
10.00
10.25
10.50
10.75
11.00
11.25
11.50
11.75
12.00
FUEL RACK NOMINAL CENTER TO CENTER

Figure 3.2


K EFFECTIVE VS. BORAL LOADING
K EFFECTIVE
.98
.97
.96
.95
.94
.93
.92
.91
.90
0.000
.001
.002
.003
.004
.005
.006
.007
.008
B-10 LOADING (ATOMS/BARN-CM)